DOCUMENT RESUME

ED 216 704 IR 010 247

AUTHOR Cohen, Vicki L. Blum
TITLE Evaluating Instructional Software for the Microcomputer.
PUB DATE Mar 82
NOTE 96p.; Paper presented at the Annual Meeting of the American Educational Research Association (New York, NY, March 1982). Best copy available.

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS Computer Assisted Instruction; *Computer Programs; Elementary Secondary Education; *Evaluation Criteria; *Evaluation Methods; Instructional Design; *Instructional Materials; *Microcomputers; Reliability

ABSTRACT

In order to develop a systematic procedure for the evaluation and revision of educational software for microcomputers, a study was undertaken by the Educational Products Information Exchange (EPIE) Institute and the Microcomputer Resource Center at Columbia University to define the criteria that are needed to evaluate instructional microcomputer programs. A set of commercially-produced educational programs for microcomputers selected for analysis. The software evaluation instrument developed and revised during the course of the project was adapted from the EPIE instructional materials analysis instrument. After the instrument was developed, eight analysts evaluated the instructional programs and an analytical procedure evolved which provides descriptive/prescriptive information about instructional software. A reliability study conducted during the project indicated that the accuracy of the analysts' evaluations ranged from 76 percent on the first evaluation to 96 percent on the final evaluation. Significant findings show that most commercial courseware programs on the market stress a drill and practice approach to the study of arithmetic and are oriented toward the elementary school level. It was concluded that most programs did not utilize instructional strategies which facilitate conceptual learning. One figure, five tables, a reference list, a glossary, and the evaluation instrument accompany the text. A copy of the evaluation instrument is appended. (Author/JL)

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EVALUATING INSTRUCTIONAL SOFTWARE FOR THE MICROCOMPUTER

by

Vicki L. Blum Cohen

Presented at the annual meeting of the AERA
New York, New York, 1982

IR010247

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ABSTRACT

EVALUATING INSTRUCTIONAL SOFTWARE FOR THE MICROCOMPUTER:
AN ANALYTICAL EVALUATION PROCEDURE

Vicki L. Blum

In the past three years there has been a phenomenal rise in the use of microcomputers in schools. When an educational software package is produced, there are no accepted criteria as to what comprises an effective instructional program. This study defines a list of criteria that are needed to evaluate instructional software for the microcomputer. Using those criteria, eight analysts evaluated the current commercial educational software programs on the market for school use. From this project an analytical evaluation procedure was developed which provides descriptive/prescriptive information about the instructional software programs. The software analysis instrument that was developed is unique in that it was designed to evaluate the capabilities of the microcomputer.

A reliability study was conducted throughout the project. This was done by using a baseline score and comparing the analysts' responses across all items. It was then possible to determine if there was agreement or variance on an item. The accuracy of the analysts' responses varied from 72% on the first evaluation to 96% on the last evaluation.

The significant findings show that most large commercial courseware programs on the market are arithmetic programs which stress a drill and practice application and are designed to be used in elementary schools. The major emphasis of the objectives was recall of previously learned facts and they did not stress higher-order skills. Few programs are designed to teach concepts, rarely are graphics embedded in the instructional content, very little user control is granted to the student, most feedback responses did not remediate the wrong answer, half the programs used some form of diagnostic management (or branching), and two of the programs had a fairly sophisticated management system.

It was concluded that most programs did not utilize many of the instructional strategies which would facilitate learning. There needs to be more programs that teach problem-solving techniques and concepts. Additional ways of interacting with the microcomputer other than drill and practice should be explored and the programs need to expand beyond just arithmetic skills. Specific guidelines and directions that consumers and producers can attend to are offered in this study.

Background

In the past three years there has been a phenomenal rise in the use of microcomputers (see Appendix A for glossary) in schools and industrial training programs. Where before large computers were too expensive, cumbersome, and impractical to utilize as an instructional device, today microcomputers are quickly becoming a common part of many classrooms. In a recent report from the U.S. Department of Education, school districts make available almost 52,000 computers to students for educational purposes. This estimated figure represents a mixture of microcomputers and the more traditional terminals connected to a large central processor. In the short time they have been on the market, microcomputers have come to outnumber terminals, proportionately 3 to 2 (National Center for Education Statistics,1981).

Microcomputers are relatively inexpensive (between $200 to $6,000 each), they use a simple language (usually BASIC), and an entire self-contained system can sit on a desktop. Such features have convinced many a school district to make the initial investment in the hardware, and without full investigation into what its capabilities and limitations really are, administrators have bought and installed the microcomputer in classrooms. The rise in hardware sales by manufacturing companies will attest to this fact.

Surprisingly, the development and sales of software packages has not been commensurate with the sales of the hardware. Small cottage-industries comprised of enterprising programmers who want to make a quick dollar predominate. Programs of questionable educational value flood the market. Space-war games and How-to-Compute-Your-Taxes are the most common programs available. When an educational software package emerges, such as the S.R.A. or Milliken series, there are no accepted criteria as to what comprises an effective instructional program.

The problem arises once the microcomputer has been bought and newly installed. The experienced (or no-so-experienced) teacher must now learn how to use it. S/he plugs in one of the free educational tapes that accompanied the microcomputer and discovers that it is of little educational worth. The program does not fit his/her students' needs, makes no provisions for individualizing the instruction, and in reality is not much different than an expensive workbook.

At present there is no systematic procedure for the evaluation and revision of educational software programs. "Instructional evaluation procedures are well-suited for empirically identifying weaknesses in educational materials, but they are grossly inadequate for prescribing revisions. Presently, revisions are usually prescribed on the basis of intuition--if at all. This is haphazard and inadequate.

Furthermore, a thorough knowledge of principles of instruction permits an analytical evaluation, as opposed to an empirical evaluation, or existing materials" (Reigeluth and Garfield, Note 3, p. 26). An analytical evaluation is quicker, less expensive and if done by a trained professional, preferably knowledgeable of instructional design techniques, is more effective in diagnosing necessary revisions in the materials.

In essence, an analytical evaluation procedure for diagnosing and prescribing revisions based upon instructional science is necessary for instructional software used on the microcomputer. Hopefully, once this procedure is developed and implemented, a systematic dissemination of the information to teachers, user and publishers will also develop.

The Evaluation Project

In an attempt to address some of these issues EPIE (Educational Product Information Exchange) Institute and the Microcomputer Resource Center (MRC) at Teachers College, Columbia University started a joint evaluation project in October of 1981. EPIE has for many years provided a systematic way of analyzing textbooks and other materials used in elementary and high schools so it was natural to base the evaluation procedure upon EPIE's system of instructional design analysis. EPIE could also publish and disseminate the evaluations to school districts in the

United States and Canada through their publication ERIC Materials Report.

The evaluation project had four major goals: 1) to develop an evaluation instrument that would provide descriptive/prescriptive information about courseware programs for the microcomputer; 2) using that instrument, evaluate the major courseware programs being marketed for school use; 3) develop an analytical evaluation procedure for microcomputer courseware that would be objective, reliable and comprehensive; and 4) investigate those criteria that are needed to evaluate instructional software for the microcomputer.

Selection of Software Programs

The following is a list and brief description of the instructional software programs for the microcomputer that have been used in this study:

Program 1

Title: Educational Micro Systems, Inc. (EMSI) Mathematics Program
Publisher: EMSI
P.O. Box 471
Chester, N.J. 07930

Copyright: 1980

Components: 7 cassettes and 1 Teacher's Manual

Subject Area: Mathematics

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation

Intended Users: Not specified in the program but it is meant to be used for all grade levels, K-12.

Microcomputer: TRS-80II, 16K
Apple II PLUS, 48K 3.3 DOS

Cost: $139.95

Description: This program is designed to have the teacher choose his/her own mathematical objectives displayed at the beginning of each tape. Based upon the options chosen a short drill and practice sequence is displayed in which a student practices computational skills. By selecting different combinations of objective codes, it is possible for the teacher to generate practice and test sessions for virtually any type of problem.

Program 2

Title: Milliken Math Sequences

Publisher: Milliken Publishing Company
1100 Research Boulevard
St. Louis, MO 63132

Copyright: 1980

Components: 12 disks and 1 Teacher's Manual

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation

Intended Users: Grades 1-8 as stated in the Teacher's Manual

Microcomputers: Apple II, 48K
TRS-80 Level II, 15K
Commodore Pet, 8K

Cost: $450.00 (disks for Apple II)
$200.0 (cassettes for TRS-80 and Commodore Pet)

Description: This program correlates with concepts presented in most basic mathematics tests. The math sequences provide individual drill and practice for students in math operations. The scope of the content is fairly comprehensive spanning eight grade levels.

The management system allows the teacher to make individual and classroom assignments, review individual and class performance, establish performance levels for each student, and receive optional printed records of student performance.

Program 3

Title: Microsystem 80, Critical Reading

Publisher: Borg-Warner Educational Systems
600 W. University Drive
Arlington Heights, IL 60004

Author: Joseph M. Scandura

Copyright: 1980

Components: 8 disks and 1 Teacher's Manual

Subject Area: Reading/Logic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Problem Review

Intended Users: Middle grades, junior high, senior high and adults, as stated in the Teacher's Manual. It was felt the program could best be used with elementary and low junior high students.

Microcomputer: Apple II, 48K

Cost: $750.00

Description: This program is designed to introduce a student to the basic rules of logic and to provide practice in reasoning skills which will aid in his/her overall comprehension of reading materials. The lessons are structured by having students read a series of paragraphs using a logical inference rule. The student must respond "True", "False", or "Unsure" to each question asked about the paragraph. A fairly complete management system keeps records of student progress and automatically branches a student up or down depending upon the level of performance.

Program 4

Title: Fact Track

Publisher: Science Research Associates
155 North Wacker Dr.
Chicago, IL 60604

Copyright: 1981

Components: 1 disk

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice

Intended Users: Young children, older children and adults who need practice in arithmetic facts, as stated in the Teacher's Manual. It was felt this was best for elementary school children.

Microcomputer: Apple II, 48K
Atari 800, 32K

Cost: $75.00

Description: This single disk program is designed to help students master the aritnmetic facts. The disk contains several sequences that the student may choose to work in. Within each sequence there are different levels of increasingly more difficult skills for the student to master. A management system is not included but records of students' progress are recorded.

Program 5

Title: Radio Shack K-8 Math Program

Publisher: Tandy Corporation
Fort Worth
Texas 76102

Copyright: 1980

Components: 5 cassettes or 3 disks depending on machine. Program included all components for any machine.

Support Related Materials: K-8 Math Cross-Reference Guide which coordinates lessons in the program with specific pages in seven different math basals.

Subject Area: Arithmetic

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation

Intended Users: Grades K-8 as stated in the Teacher's Manual

Microcomputer: All TRS-80's

Cost: $199.00

Description: This program is designed to supplement the existing mathematics curriculum by providing: 1) student placement; 2) skill building lessons; 3) tests. A student works his/her way through the program, and depending upon the level of performance is branched up or down. Once the lesson is completed, a record of the student's progress is reported. A rudimentary management system is included.

Program 6

Title: SRA Computer Drill and Instruction: Mathematics (CDIM)

Publisher: Science Research Associates
155 North Wacker Drive
Chicago, IL 60606

Copyright: 1980

Components: 30 disks and 3 Teacher's Manual (the same Manual for the entire program)

Subject Area: Mathematics

Curriculum Role: Supplementary/Adjunct

Mode of Interaction: Drill and Practice
Computation
Tutorial

Intended Users: Grades 1-6, older students or adults as stated in the Teacher's Manual

Microcomputer: Atari 800 (40K)
Apple II or Apple II PLUS (48K)

Cost: $1225.00 (Managed version)

Description: This program enables students to practice basic arithmetic skills and immediately find out how well they are doing. It also offers a tutorial instruction that students can request as they need it. A management system is available to monitor and record each student's progress, continually diagnosing and delivering exercises at the appropriate level of difficulty.

These particular programs were selected because they were the larger curriculum packages produced by publishers which would have an impact on the school curriculum in terms of instructional content and budgetary requirements. By reading journals and magazines, attending national conventions which promoted microcomputer courseware, talking to producers and distributers of the software materials, writing letters to the publishers and consulting subject-matter experts about what courseware was available it was possible to acquire these six programs for preview and evaluation.

These programs represent a high percentage of the total population of large curricular courseware programs available for school use in the spring of 1981. Most of the major programs produced by publishers at that time were included. Many more programs were on the verge of being produced or have just been marketed. This sample is a good example of the industry's first attempt in the field of instructional software for the microcomputer.

The Evaluation Instrument

The software evaluation instrument that was developed during the course of the project was adapted from EPIE (Educational Product Information Exchange) Institute's instructional materials analysis instrument. It systematically analyzes courseware in terms of four constructs: intents, contents, methodology and means of evaluation. In addition, it looks at specific instructional strategies which should be employed to facilitate instruction.

The form went through many revisions during its development throughout the course of the project. This formative process became an important part of the project. The starting point was to compile a list of criteria that needed to be included in the instrument. This involved investigating those attributes which would have a potential impact upon learning during the instructional process and are clearly observable in a software program so that evaluators could assess their presence or absence. Two kinds of attributes were used: 1) those that are generic to all media of instruction, have been shown through research to affect learning outcomes, and are therefore recommended instructional strategies; and 2) those that are necessary to consider in the design of courseware for the microcomputer, are virtually unresearched with regard to learning theory, and potentially affect learning outcomes in a unique way. This study was concerned with both kinds of attributes although much of the study concentrated upon

investigating the attributes of the second kind--those necessary in the design of courseware for the microcomputer. As the software was evaluated using the instrument new attributes were investigated, and the evaluation form changed accordingly, always keeping the original format, but undergoing a refinement in the list of criteria to be included. The resulting evaluation form has been based upon those attributes unique to the microcomputer and is not a generalized evaluation instrument that could be used for all media. It uses both kinds of attributes to evaluate software for the microcomputer.

The following process traces the development of the evaluation instrument that was used during the this project.

Form 1

The first stage in the process was to compile an initial criteria list which attempted to isolate those attributes that are necessary to consider in the design of courseware for the microcomputer. This initial criteria list was compiled from four sources: 1) a thorough review of the literature in the areas of computer-assisted instruction, instructional design and learning theory; 2) subject-matter experts who were consulted on the design of courseware for the microcomputer; 3) previous experience in analyzing instructional materials; and 4) a survey of the existing instruments used to evaluate instructional software.

From this list a preliminary instrument, Form 1, was developed . This form was circulated among faculty and subject-matter experts and feedback was collected. An initial learner verification and revision (LVR) session was held using a single person to try the form out on a software program. Revision of the evaluation form was the intent of this session and feedback was collected through observations and informal interviews. A log of revisions was kept throughout this phase and all recommended revisions were incorporated into the form.

Form 2

Form 2 was developed and then circulated among faculty and subject-matter experts. All recommended revisions were noted in a log of revisions. In addition, a pilot study was conducted using three doctoral students enrolled in a graduate course on instructional materials. All three were in the Instructional Technology and Media program at Teachers College, and all came from an educational background involving instructional materials. An initial meeting was held where training was given to the three students on use of the form, terminology, and the unique capabilities of the microcomputer. Each criterion-item was discussed and feedback was collected regarding clarity and importance of each item. Any item which caused confusion was either eliminated or revised. The three doctoral students used the form to evaluate one complete courseware

program. Their responses were analyzed and any changes on the form they suggested were noted.

Form 3

After the revisions from the pilot had been completed, Form 3a was developed. At this point the evaluation study formally began. Seven analysts were recruited to partake in the project. Each analyst went through a two-day training session designed to train them in the use of the instrument and to familiarize them with microcomputers and the programs to be evaluated.

After completion of the training session, all analysts evaluated Program 1, 2, 3 and 4 using Form 3a. After each evaluation, a debriefing session was held whereby the software program was discussed in detail, and a consensus was obtained on each item. At this point, each item was thoroughly examined and discussed, and all potential revisions were noted.

Form 3b was developed based upon the concerns that the analysts had noted . Programs 5, and 6 were evaluated using this form and Programs 1, 2, 3 and 4 were reexamined using the new criterion items so that all the evaluations would be consistent.

Form 4

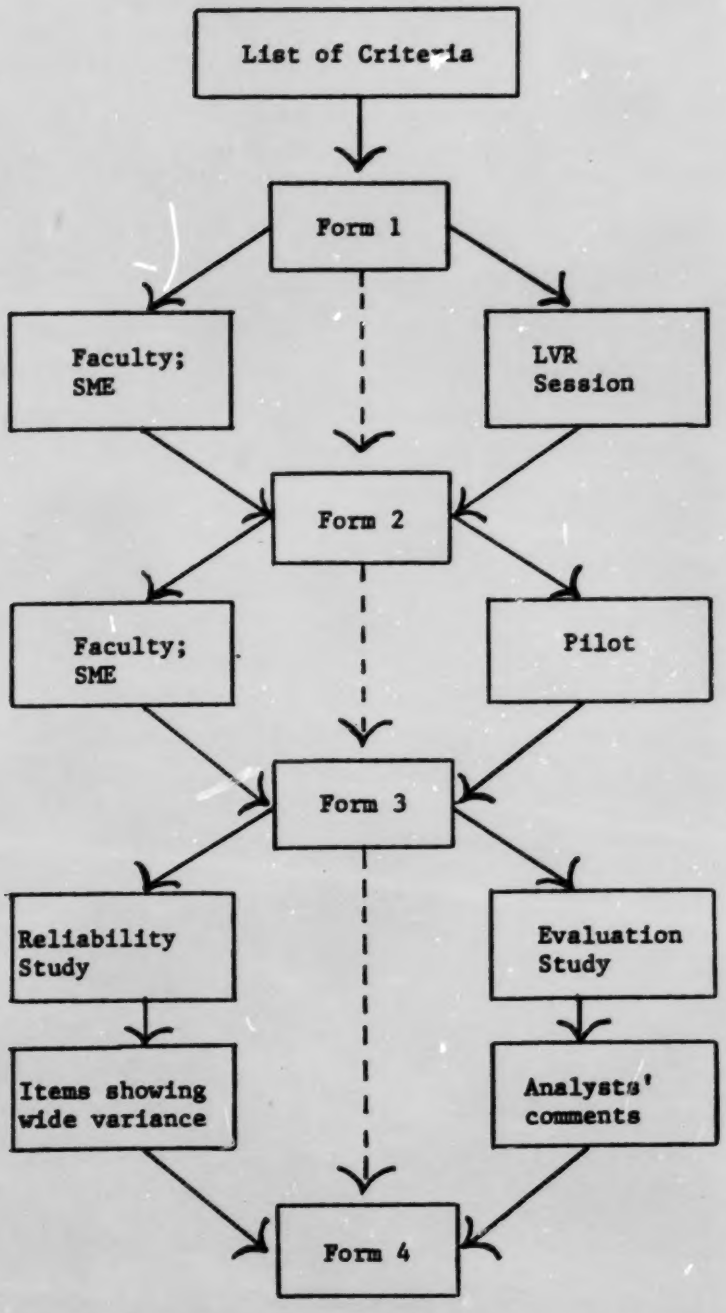
The last revision of the form attempted to make the instrument more concise after the six programs had been evaluated. Each analyst was asked to cross out those items

on Form 3a they considered unnecessary or redundant. This information was collected and Form 4 was developed. This is the form that is currently in use.

Figure 1 traces the development and revision of the evaluation instrument over the course of the evaluation project.

Figure 1

Development and Revision of the Evaluation Instrument



The evaluation instrument that is in use today (see Appendix B) can be used to evaluate a curriculum courseware package. It can also be used as a checklist that producers could attend to during developmental stages or selection committees could use to assess the merits of a courseware package. The form is unique in that it was developed to assess the capabilities of the microcomputer and so looks specifically at how that technology can best be utilized to facilitate instruction. The formative evaluation process has helped to yield a viable instrument that is a solid starting point for evaluators, selectors and producers of courseware who need guidelines and standards for determining a worthwhile courseware program.

The Evaluation Procedure

One of the purposes of the evaluation project was to develop a systematic procedure for evaluating educational software programs designed for school use.

Once Form 3a had been developed, seven analysts were recruited to evaluate the six courseware programs. The analysts came from two different backgrounds: four of the group came from a computing/mathematics background and were graduate students in the Mathematics in Education Department at Teachers College; the other three came from an instructional design background and had extensive experience in instructional materials development and evaluation. The group therefore possessed technical programming expertise

and instructional design skills so that each program was evaluated in a comprehensive way.

A two day training session was initially held to acquaint the analysts with the evaluation instrument and the technical aspects of the microcomputer. After this two-day session all seven analysts were ready to evaluate the first courseware program. The analysts were carefully instructed on how to evaluate the programs. They were told three different types of responses were required from them: one was an objective, analytical response to determine if an attribute was present or not present; one was an educated, subjective judgment to determine the appropriate use of an attribute; the third kind of response was an expression of opinions and feelings in the summary statement. It was emphasized that those opinions must be kept in abeyance while filling out the form and that an objective attitude should predominate throughout. Only during the summary statement could opinions and feelings be expressed.

The following procedure was outlined to the analysts. Each analyst was to individually sit down with the Teacher's Guide that accompanied the software program and read through it. They were then to fill out the form as far as they could before sitting down at the microcomputer and looking at the software program. In most cases this meant they were able to complete the first three pages. They were then to preview the courseware in the microcomputer, carefully analyzing it for those criteria listed on the form. Each

analyst was instructed to write notes on the back of the form for future reference. After they had previewed the program thoroughly, they they were to fill in the rest of the form. If there were items that could not be answered they were required to go back and look at the program again and again if necessary. Once the form was completed, a summary statement was required which let the analysts express their true feelings; it gave them a chance to address such issues as the actual quality of the program and if the microcomputer was the appropriate medium for the content. It was emphasized that the total procedure was to be done alone. Analysts could not share their ideas during this process so as not to compromise the reliability study.

Once the form was filled out a debriefing session was held. The analysts could now verbally express to each other their opinions about the software program and try to reach some conclusions about the criteria on the form. These debriefing sessions, which occurred after each evaluation, were an extremely important part of the whole evaluation procedure; the discussions that emerged from these meetings became the basis for the final written evaluation reports. These sessions became the primary means of reducing variance in future evaluations as it gave the analysts a chance to interpret the items as a group and understand what kind of response was expected for each item. Through group interaction and dynamic discussions, the analysts were able to compare and discuss each of their responses on the form.

After each debriefing session, this researcher would take all the analysts forms which had been independently filled out and conduct a reliability check to determine how much scattering and clustering of responses occurred for each item or how much agreement and variance there was between the analysts. This reliability check was done on a large matrix which listed every item on the form and all possible responses to each item. Once this was completed and analyzed to determine causes of variance, an evaluation report was written up based upon the compilation of responses from the analysts. Instructional design congruence was a crucial issue for each program--or whether the constructs meshed so that there was a good fit between the intents, contents, methodology and means of evaluation. This meant asking such questions as whether the intents matched the content, and whether the objectives were evaluated properly. If a program displayed congruence there was integrity or harmony of instructional design (EPIE Materials Report, 1977). Prescriptive comments under the heading of "Recommendations" were made for each software program. The purpose of this section was to diagnose specific deficits or problems in the materials and to prescribe revisions that better conform to the principles of instructional science. These recommendations are intended specifically for publishers.

After the first three programs were evaluated the reliability check indicated that analysts were still having difficulties interpreting some of the items and many of the analysts were complaining. Those from the Mathematics/Computing background were having trouble understanding the concept of congruence and were not totally clear as to what a rationale or behavioral objective was and why they were important. The instructional designers were having some difficulty grasping the scope of a mathematics curriculum and judging whether the software was adequate in its range and technical design. In addition, many of them complained about trying to evaluate a program alone. They all felt the need to talk to someone during the process of evaluation; they felt that it would make the process easier, more pleasant and more reliable. After some thought and discussion, it was agreed that pairs of analysts would start to evaluate the programs together with the provision that the analysis form must be filled out independently by each analyst and there could be no sharing during that period.

At that point the process of evaluation evolved into a cooperative, working procedure. The analysts started to share their expertise among themselves while looking at the software in pairs (or teams, as so often occurred, especially when only one Apple microcomputer was available). The reliability checks started to show less scatter over items and the debriefing sessions became less heated with

the analysts showing more consensus on most issues. In short, social interaction became a very important part of the process of evaluating software for the microcomputer. Whether this is true of all evaluation processes or just for this specific technology is only conjecture at this point.

The question must be asked at this point whether this procedure of social interaction among analysts would yield a biased evaluation and if the resulting situation destroys the credibility of the evaluation and the validity of the evaluative judgments? Does this arrangement violate the basic Principle of Independence (Scriven, 1976) and encourage bias? Scriven (1976) claims that there are wide sources of bias in evaluation and preventative measures for them. One arrangement which discourages bias is independence which he says is essential, impermenent and situational. Scriven is talking about program evaluation in organizations and the need to hire independent external evaluators which is a totally different situation from the one described here.

It might be argued that pairing of analysts to preview courseware might bias the subsequent evaluation. Yet the actual written evaluation is done independently and the process of previewing the courseware with another analyst from a different background will hopefully add to the comprehensiveness of the final evaluation. The act of evaluating courseware in isolation can become a tedious and frustrating experience; the process of sharing can

alleviate much of the anxiety. Only when the evaluation form is completed can the analysts express their opinions to themselves at the debriefing session although one might influence the other during the previewing.

The Delphi technique is a similar method used to attain consensus which tries to ensure independence of the evaluators. Ordinarily a small group of experts on a specific topic is identified. Their opinions are solicited from them through mailed questionnaires and the data is returned to them as group data. Each person is unaware of who else is responding so that no single strong personality shapes the group. After repeated questionnaires, the group's opinion usually comes to reach more of a consensus (House, 1973, p. 275). Such an approach ensures the independence of the evaluators but is not a viable procedure to use in this case. Learning about the microcomputer and scheduling analysts to preview courseware demanded social interaction among participants. The whole process was a unique learning experience which became an active exchange of ideas. Stifling that exchange to achieve total independence seemed unnecessary and unhealthy.

Thus, the analytical evaluation procedure evolved and changed over the eight months of the project. It went from a process which research and previous experience had prescribed as the appropriate method of evaluation to one which was dictated by the needs of the analysts who were directly responding to the new technology. Faced with the

dilemma of contaminating a reliability study or being flexible enough to respond to the analysts' complaints, this researcher could only choose the latter direction. Being involved in research which investigates such a new technology, it seemed imperative that a traditional, experimental approach to evaluation not interfere with the important message the analysts' were conveying, that the process of evaluating courseware on the microcomputer needs social interaction.

Reliability

When the evaluation project using the seven analysts began, it was necessary to have interrater reliability to ensure validity of the assessments across each item. To determine statistical reliability was difficult: the number of analysts was small and many of the items required a descriptive entry. What was needed instead was a working method whereby wide variance could be pinpointed, categorized according to cause, and then reduced if possible.

To achieve reliability, a "standard" rater score using the principal investigator's scores as a baseline was compared against the analysts' scores across all items. What emerged was a four-page matrix whereby every item on the form was listed on a different row. The columns were numbered and each analysts' score was ranked according to their response. In addition, each analysts's score was

color-coded so that the responses of an analyst could be traced from row to row. It was then possible to look at each item and determine whether there was scattering of responses across an item (which indicated wide variance) or clustering of responses in an item (which indicated agreement). This was done by looking at each item and determining the distribution of analyst responses. If four or more of the analyst scores clustered around one response this was defined as agreement. If three or more of the scores were scattered over a number of responses, this was defined as variance. A score is defined here as the actual rating or marking an analyst made for a particular item. A response is defined as the possible list of answers an analyst could score . Thus, if all seven analysts scored an "always" response on the fifth item of the form, that item displayed agreement. If, however two analysts scored "always", two scored "sometimes", and three scored "never" that item displayed variance. If an item showed variance it was circled and the responses were analyzed to determine the cause (see Appendix C).

There were basically three reasons for the variance: 1) error in scoring due to inadequate training and/or background factors; 2) ambiguous wording of an item on the form; and 3) subjective judgments which were a required response on some of the items on the form. Each reason is explained in greater detail below.

1) At times scores of one or two analysts would differ from the "standard" score and from those of other analysts; this was considered true "error" because it indicated that the analysts were making mistakes in scoring a particular item. Error is defined as that type of response which is due to incorrect or wrong scoring and cannot be accounted for by either ambiguous wording on the form or the necessity to make a subjective judgment. This could indicate that retraining was needed. Often what occurred, however, was an error in scoring due to the nature of the analysts' background. The Mathematics experts' responses on an item would differ from that of the instructional designers. This split in opinion due to background or just personal preference is a difficult issue in interrater reliability studies. There is no way to ensure that training and retraining will account for varying background factors so that this error (or variance) can be reduced. In fact, it is often desirable that some variance occur so that different values and perspectives can be expressed which will result in a more valid and thorough evaluation. This guards against imposing absolute standards.

2) Frequently a poorly worded item on the form would cause confusion and uncertainty on what was expected. This would cause a scattering of answers across the columns. This occurred most frequently when the form was being revised and initially used by the analysts. Non-specific terminology and vague questions caused much discussion and

dissatisfaction. In evaluation studies it becomes mandatory to define every word and every item as clearly and as operationally as possible. What is often clear in theory, is impossible to observe during evaluation.

3) At times an item on the form required that a judgment had to be made concerning the appropriateness of an attribute (i.e., "judge whether feedback is used appropriately"). This would result in a scattering of answers across the columns or a clustering around responses based upon the analysts' background. There is basically little that can be done to reduce variance in evaluation studies when judgments have to be made as they are based on personal opinion and retraining would not alleviate the problem.

The other miscellaneous reasons for the variance were due to confusion on terminology (i.e., what a "cue and/or prompt" was) and confusion with regard to the software program's technical design. Some courseware programs were relatively straightforward and easy to evaluate using the form. Other programs were much more complex and it was difficult to rate some items. A descriptive response was the only way to respond to some of the items which could not fit into an "always", "sometimes", "never" format. Some programs aroused much more controversy and discussion; it often then became a matter of values rather than analysis which interfered with the intended objectivity.

The following methods were used to reduce variance and establish higher interrater reliability:

1.) Debriefing sessions were always held after each analyst evaluated a program and filled out the form. These sessions became the predominate means of decreasing variance on future evaluations. Through group interaction and dynamic discussions, a consensus would finally be reached on various items that required judgment. These sessions helped the individual analysts start to function as a team with a common insight into interpreting the separate items.

2.) If there appeared to be no logical reason for the variance, during the debriefing sessions this researcher would explain what a particular item meant and how it should be interpreted.

3.) After the first three programs were evaluated, analysts felt strongly that the process of evaluation required social interaction. Analysts were than paired according to schedules and background (math experts paired with instructional designers). The evaluations were than done in teams while the form was filled out separately by individual analysts. This greatly helped to reduce variance and became a much more enjoyable experience for all.

Table 1 shows the amount of variance attributed to each cause for the six programs evaluated.

Table 1

Cause of Variance

Program	Total No. of Items[1]	Error[2]	Poorly Worded Items[3]	Judgments[4]	Misc.[5]	Total Variance[6]	Agreement[7]
1	89	11	5	6	2	25	72%
2	91	8	1	3	—	12	87%
3	101	6	1	9	—	16	81%
4	101	1	3	3	3	10	90%
5	112	5	4	3	1	13	88%
6	112	2	2	3	3	10	92%

1. Total number of items on the evaluation instrument that the analysts were required to score

2. Analyst error in interpreting and scoring the items which was usually due to inadequate training and/or background factors

3. Ambiguous wording on the evaluation instrument which would cause confusion with regards to scoring an item

4. A subjective judgment which had to be made by analysts on certain items of the instrument regarding the appropriateness of an attribute

5. Other miscellanious reasons for variance such as confusion on terminology or inexperience with a program's technical design

6. Total number of items on the instrument which displayed variance whereby three or more of the analysts' scores were scattered across the responses

7. Total number of items on the instrument which showed agreement whereby four or more of the analysts' scores were clustered on one response

Table 1 indicates that the methods used to increase reliability were effective. For instance, of the total 112 items in Program 6, the analysts showed 92% agreement in scoring them, with only 8% of the items displaying variance. This is in sharp contrast to Program 1 where only 72% of the total 89 items were ranked the same by analysts and 28% of the items displayed variance. If the cause of variance is taken into account, out of the ten items that showed wide variance in Program 6, two are due to error in interpreting and scoring the items, which means that 4% of the items showed error that is unaccounted for. Thus, the analysts actually achieved interrater reliability with 96% agreement for the last program.

Which single method of reducing variance had the greatest influence on this reliability cannot be determined but it is clear that by Program 6 a tighter, more easily understood form had been developed, a procedure of evaluation was established, and group dynamics had merged disparate individuals into a cohesive unit, all of which contributed to the high interrater reliability.

Instructional Design Attributes

During the course of this study a list of attributes were compiled that potentially affect learning outcomes, are clearly observable in the design of instructional software, and are included in the evaluation instrument. This list was an expanded version of the original criteria list used

to create the evaluation instrument. The list developed slowly throughout the study and came from three sources: 1) a thorough review of the literature; 2) subject-matter experts who were consulted throughout; and 3) the actual experience of evaluating courseware whereby certain attributes were deemed fairly significant factors to consider during evaluation by the analysts.

This list could be divided into two kinds of attributes: 1) those that are generic to all medium of instruction, and are recommended strategies to use for instructional design; and 2) those that are necessary to consider in the design of courseware for the microcomputer and potentially affect learning outcomes in a unique way.

Table 2 lists both kinds of attributes used in the final evaluation instrument. It should be noted when looking at Table 2 that there is no one-to-one correspondence between these two lists and that item number one in the "Generic to Instructional Design" list bears no relation to item number one in the "Necessary For the Design of Courseware" list.

Table 2

Attributes Necessary to Consider

in the Design of Courseware for the Microcomputer

GENERIC TO INSTRUCTIONAL DESIGN	NECESSARY FOR DESIGN OF COURSEWARE
1. Specified target audience/ intended users	1. Curriculum role: Adjunct Mainline Management only
2. Specified learner entry competencies	2. Mode of Interaction Drill and Practice Tutorial Game Simulation Problem Solving Exploration
3. Specified rationale, goals and objectives	3. Student sequence Nonlinear Varied by teacher/student
4. Objectives stated behaviorally	4. Instructional Text Format
5. Objectives stated in terms of the learner	5. Graphics embedded in content Animation
6. Objectives include higher-order skills	6. Graphics used appropriately
7. Learners are informed of the objectives	7. Cues and/or prompts used
8. Range and scope of content is adequate to achieve program's intents	8. Action occurring on the screen
9. Total program sequence	9. User control
10. Preinstructional strategies: pretests advanced organizers title at beginning of unit	10. Computer-Managed Instruction
11. Instructional text format	11. Feedback
12. Concept learning	12. Records stored on magnetic devices for future retrieval
13. Vocabulary appropriate for learner	13. Program content designed to be altered
14. Graphics embedded in content	14. Random generation
15. Graphics used appropriately	15. Packaging designed for component parts
16. Demonstration of the exercise	16. Teacher's Manual and Student Manual
17. Teacher's Manual	17. Technical design which allows: Quick response time Quick loading time
18. Instructions clearly stated for the student	
19. Evaluation components	
20. Record-keeping device	

It is important to note here that all media contain some aspect of each attribute that is necessary for microcomputer design. Drill and practice, tutorial, user control, feedback can be used in the design of other media besides the microcomputer. A programmed text can be an effective tutorial and grant the user much control. The key issue is the extent to which the microcomputer can interact with the user so that a sophisticated and unique learning environment is established. The essential attributes are those which must be considered in the design of software for the microcomputer so that the unique capabilities of the microcomputer are utilized. Each attribute that is necessary to consider in the design of courseware for the microcomputer will be discussed below.

Curriculum Role

The role that the microcomputer will play in the classroom is unique and it cannot be viewed as just another medium of instruction. Rather the computer has the potential of modifying the curriculum and absorbing much of the labor-intensive responsibilities which the teacher has traditionally maintained. By reducing many of the time-consuming tasks that the teacher is required to do, and by functioning as a surrogate "tutor", the microcomputer will lower the teacher-pupil ratio and allow a greater amount of individualized instruction to occur. Courseware packages for the microcomputer can function in three

capacities in the classroom:

1.) as supplementary "adjunct" applications whereby teachers use them as supplements to the regular curriculum. Problem solving, simulation, and drill and practice are examples of adjunct applications of the microcomputer.

2.) as a "mainline" or basic course that is used to teach students a complete curriculum unit. No input from the teacher is needed and the microcomputer functions as a "tutor" teaching concepts and providing drill and practice on these concepts. Usually records are maintained and all instruction is managed by the computer.

3.) as a management system whereby all the records for a curriculum unit are stored and managed by the computer. No instruction is provided with this application of the computer; its role is to provide accurate records on whether each student has mastered specific objectives and pinpoint the level each student is functioning at.

Other applications of courseware programs for the microcomputer might be:

1.) as a pre-programmed authoring device for teachers and students to create their own programs;

2.) as a programming course on computer literacy whereby students learn how to program the computer;

3.) as an assessment device whereby tests are given on the microcomputer and the student's responses are immediately scored and reported to the teacher.

Mode of Interaction

How a courseware program for the microcomputer functions in the curriculum is dependent upon how the student interacts with the subject-matter and computer. The various modes of interaction are unique to the microcomputer in that the student is able to interact directly with the computer and receive immediate feedback after the response. The six types of interactions that can be employed using the microcomputer are:

1.) drill and practice
2.) tutorial
3.) gaming
4.) simulation
5.) problem solving
6.) exploration

The evaluation instrument originally included three additional modes: problem review, diagnosis and prescription, and computation. It was found that these three were difficult to isolate and differentiate from each other. The six modes of interaction listed above are those most frequently used in courseware applications and are necessary aspects to consider in its design.

Student Sequence

A unique and interesting attribute of courseware design is the sequencing of a student through the content material. The issue of a program being nonlinear adds a new dimension

to instructional design. Basically, the content is organized in a similar fashion across all medium with task-analysis, natural unit sequencing, and chronological progressions being common methods. But how the student progresses through the content can be unique in microcomputer courseware since a linear path is neither necessary or desirable. Courseware can be designed to allow the student to choose his/her own sequence and follow a different route each pass through the content. The design of the courseware program will determine who has control over the sequence--the program, the student, or the teacher. The more that the sequence is fixed by the program in a linear path, the less likely a student can vary the sequence.

An important student option is to be able to exit from an activity and enter a new one, if so desired. A book can be closed, a chapter can be skipped, a workbook page can be ignored. On the microcomputer, it is extremely frustrating to be forced through one activity after another with no choice but to continue. The option then becomes one of turning the machine off and walking away.

The other option available in courseware design is to have the teacher determine the sequence for a student. The teacher would then be capable of individualizing the sequence for each student. This attribute is another essential way that the courseware can be designed to capitalize on its unique capabilities.

Instructional Text Format and Frame Display

It is essential that the instructional text be formatted on the screen for easy reading. The nature of the screen is such that long sentences become difficult to read and understand when viewing the screen. Most video monitors used with microcomputers have a 250-line resolution, or about half the resolution quality we are accustomed to seeing in print materials. Reproducing the hard edges required by alphabets and numbers is therefore a technically difficult task for microcomputers unless they are programmed for rather large print. As the size of the print increases, however, the amount of memory available for other tasks is depleted. Because the print is inherently difficult to read, it is especially important that the formatting and frame display not add to the viewing difficulty. Lines of text must have space between them, long passages should be left to textbooks and magazines, and the screen should completely clear before each new display rather than have frames fill up line by line.

Graphics

Those graphics that are embedded in the instructional content (or are an integral part of the instruction) contribute to the learning process by presenting a visual model of the information to be learned. Graphic (as opposed to textual) representation of concepts takes advantage of a powerful capability of the microcomputer and is often easier

for children to store in their memories. It can facilitate recall by inducing them to actively construct their own mental representation of the information they are trying to learn (Flavell, 1977; Wittrock, Note 4).

Graphics used to enhance either the content or the feedback are helpful motivational devices but presume that the presentation is print-oriented. This use of graphics relies predominately on print or numbers to convey ideas while providing a graphic supplement to enhance the content. A visual representation is not included to facilitate learning or to induce recall. An important consideration is to ensure that the graphics do not distract from the content being presented and interfere with the program's intents.

Cues and Prompts

Just as a tutor can employ various techniques to help stimulate a student's recall, so can a good courseware program insure that cues for retrieval are available to the learner. These "cues" or "prompts" usually jog the memory and this contact gives rise to the feeling of recognition (Flavell, 1977; Gagne, 1977).

To adequately cue correct responses, the courseware program should respond in an interactive way. When new concepts or terms are being introduced, the program should maximize the number of cues to insure a correct response. In contrast when a student knows the subject well s/he can respond correctly without cues. The technical term for

withdrawing the cues is "fading". This should be done in a gradual process because if cues are faded too rapidly, the student will make many incorrect answers (Markle, Eigen and Komoski, 1961). For example, if a student is trying to spell "trade", the first prompt may be "-rade", the next one "- - ade", the next one "- --de", and the last one "- - - - e".

This capability is one that the microcomputer can utilize based upon individual performance. It is a unique, interactive feature that can be employed to facilitate learning.

Action on the Screen

There is very little research done in this area, but an essential attribute of any courseware program is to see some kind of graphic movement on the screen other than just words or numbers. The graphic capability of the microcomputer allows for a wide range of animated movement. Unfortunately this aspect is often ignored in educational settings resulting in boring, stagnant programs. Anyone who has walked into an electronic arcade recently knows the exciting capabilities of the microcomputer in terms of graphics, color, and movement.

User Control

Perhaps user control is one of the greatest capabilities of the microcomputer. The whole notion of interactivity is realized when courseware allows the student

to weave his or her own educational environment by controlling:

- o the amount of time allowed for solving the problem (i.e., Can the user choose how may seconds each problem is presented so that he/she can quicken or slow down the pace?);
- o the rate at which the display material is presented so that the user can read the information at his or her own pace;
- o the choice of sequence so the user is not confined to a linear path;
- o where entry into the program must begin;
- o exiting an activity at any time;
- o reviewing instructions;
- o options available in the presentation such as "HELP", "HINT", "ESCAPE" keys.

Computer-Managed Instruction

If a courseware program is to utilize the full capabilities of the microcomputer effectively, it should have a sophisticated management system. Individualized instruction traditionally has been difficult to institute due to the labor-intensive tasks involved. Because of this, educators are starting to become aware of computer-managed-instruction (CMI) as a means of alleviating the time-consuming demands of managing individualized instruction.

By managing the student's performance, the microcomputer should: 1.) collect and store data from the learning situation; 2.) diagnose each student's status based upon performance; 3.) prescribe activities to the student by moving a student forward to the next unit or assigning a student activities to eliminate a deficiency (commonly known as branching); 4.) provide reports on student progress (Baker, 1981). One of the more important considerations when evaluating a management system is the technical ease of using the program. If the courseware program is cumbersome and difficult for the teacher to operate due to an elaborate management system, the primary purpose of the system is defeated--to alleviate the teacher of time-consuming tasks when individualizing instruction.

Feedback

Research on feedback has shown that the main function of feedback is not to strengthen or reinforce correct responses, but to locate errors and provide information so that the learner can correct them in his or her mind. Providing only positive feedback is less facilitative during acquisition of instruction than giving negative feedback (Anderson, Kulhavy, and Andre, 1972; Barringer and Gholson, 1979; Hartley and Lovell, 1978; Kulhavy, 1977). Therefore, research recommends that feedback should be used after wrong responses and can be redundant and unnecessary after correct answers. In addition, behavioral

psychologists have shown that an intermittent or partial reinforcement schedule maintains the highest rate of learning. Not only is it unnecessary to reinforce each response, it is preferable not to do so (Homme and Tosti, 1971).

Appropriate use of feedback is an important issue in evaluating courseware. The following should be considered:

1. Feedback should be non-threatening and not "yell" at the student for a wrong answer. A "friendly" courseware program is one that is interminably patient without penalizing the student.
2. Feedback should be immediate and inform the student whether the answer is correct or incorrect and what the correct response is. It is also helpful to explain why the response is wrong.
3. Feedback should not over-reinforce correct responses with elaborate praise every time the student answers correctly. For very young children or slower learners an abundance of positive feedback might be necessary at first, but an option should be available to fade out the constant feedback.
4. Feedback should remediate. A tutorial or explanation is often necessary to help correct the student's answers. The student should also have some way of matching his or her incorrect answer against the correct response.
5. Feedback should not reinforce wrong answers by

providing a more rewarding graphic for a wrong response than for a correct response.

6. Feedback should be relevant for the user's age and level.

Records Stored on Magnetic Devices

The microcomputer can interface with two forms of electronic storage devices--magnetic cassette tapes which use an audio tape recorder and digital magnetic disks ranging from small floppy disks to large hard disks used in one or more disk drives. The advantages of the magnetic disks far outweigh the higher price of a disk drive over the audiocassette recorder. The disk allows cumulative records for each student to be stored and immediately accessed at a future time. A student can complete a lesson, turn the machine off, and, later in the day or week the teacher can quickly retrieve the student's records. With cassettes no permanent records can be stored on the tape. When the machine is turned off all records are lost. This capability of magnetic disks adds to the quality and feasibility of implementing computer-managed-instruction.

Content Designed to be Altered

An option available to courseware programs on the microcomputer is to have the content designed to be altered by the teacher or student adding to it. A few programs from Minnesota Educational Computing Consortium (MECC) take advantage of this feature by having the teacher and/or student create their own word lists and spelling lists which are then stored on the disk and become part of the program. This flexibility allows the program to be adapted in many different types of situations and can be easily integrated

into the curriculum. This feature is not widely utilized but has great potential for educational purposes.

Random Generation

A simple but extremely useful attribute that can be utilized in courseware programs is the random generator. This built-in feature will generate a universe of items at random so that no one set of exercises, words, or items will ever appear in the same order the next time they are generated. A simple way to see if a program is using random generation is to go through a few exercises in a lesson, note the order of the problems, turn the machine off, and start the same lesson again. If the problems are generated in a different order, you know that random generation is being used. If the same exact problems appear, random generation is not being used. This feature is a very useful and helpful device that should be utilized in courseware programs, especially those that are of drill and practice application.

Packaging

Although good packaging is essential to all instructional materials, microcomputer courseware contains some unique aspects which should be looked at. First, it is important to consider how the component parts (disks and/or cassettes) can be packaged so that they do not fall out of the container. Second, the disks and/or cassettes must be packaged so that they can be distributed among many teachers

being that the large programs are designed to be used across grade levels. The packaging should take this into account and be designed in such a way that a few copies of the Teacher's Manual are provided. All disks and cassettes should be clearly labeled according to subject area, lesson numbers, and grade-levels.

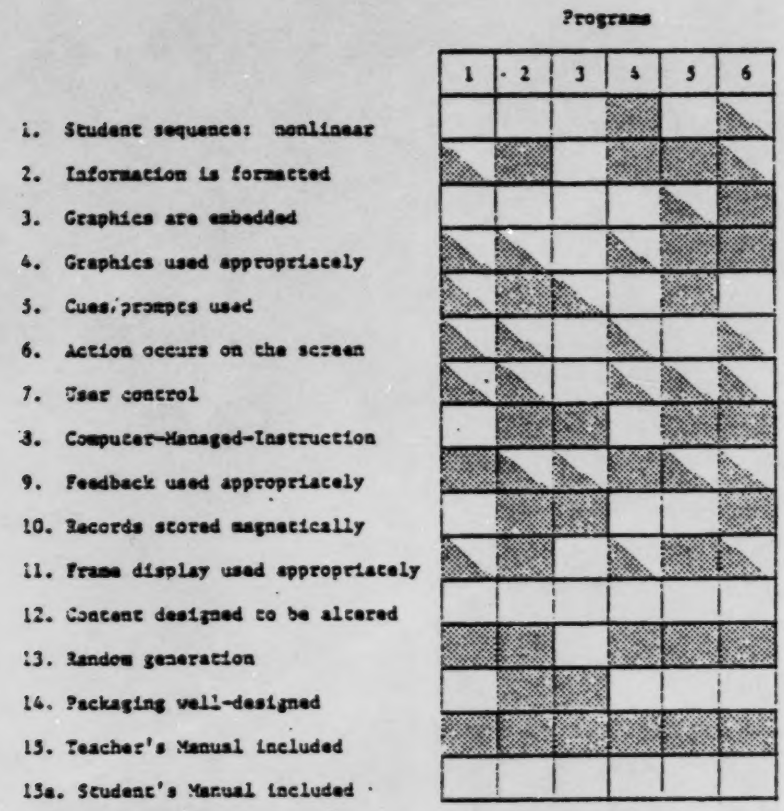
Teacher's Manual

The Teacher's Manual should contain: a) sufficient information to teach the teacher how to technically manipulate the program; b) classroom strategies for using the program; c) specific instructional activities to integrate the program into the curriculum. Also needed is a Student Guide to help the student access and technically manipulate the program. To alleviate fears and resistance, both guides should be extremely well organized, clearly stated, and provide a step-by-step approach.

Table 3 shows the use of these attributes in the six programs evaluated during this study.

Table 3

Use of Attributes Necessary to the Design of Courseware



Key:

= Always

= Sometimes

= Never

It is interesting to note in Table 3 how rarely a nonlinear student sequencing is used, that graphics are rarely embedded in the instructional content, and that none of the programs' instructional design included content that could be altered for teacher/student use.

Treatment of Data

To help focus on a broader, more general framework, it was necessary to take all of the analysts' evaluations for each program and to merge them across each item listed in the evaluation instrument so that a profile could emerge. Each profile represented those items that were included in the design of a particular program and those items that were excluded. A comparison of the six programs was then possible and conclusions could be drawn as to what items the market was attending to in its design considerations.

The procedure utilized was similar to that used in the reliability study. Using the same matrix developed for the reliability study (see Appendix C), it was possible to take the analysts' responses for each program and going item by item, reduce the seven responses to one response called a ranking. This was done in the following manner. If there was clustering of responses (indicating consensus) for an item, this indicated agreement concerning that item and one ranking was derived. Thus, if all seven responses clustered in Column 3, there was substantial agreement that the item was "Never Present" in the program and so the ranking of

"Never Present" for that item was determined. If there was wide variance across an item (indicating little agreement among analysts) two sets of criteria were used to determine the ranking. 1) The "standard" rater score representing this researcher's scores as a baseline were noted and given top priority. This researcher's judgment on items where wide distributions of responses occurred was considered the most reasonable way of solving the disagreement. 2) The ranking with the largest amount of clustering was noted and given second priority. For example, if an item showed half of the analysts' responses clustered around Column 2 and this cluster included the baseline score, that item was ranked as "Sometimes". If one or two of the analysts' scores clustered around Column 2 and this included the baseline score, that item was still ranked as "Sometimes". The situation never arose whereby the standard rater score was an isolated response and all the other analysts chose a different response. There was always enough agreement between analysts' scores and the standard rater score to make a definitive decision regarding a ranking.

Summary of Findings

Table 4 represents the compilation of this procedure and is a breakdown of all the items on the evaluation instrument by programs. From this table it is possible to determine how many programs attended to certain design considerations.

Table 4

Breakdown of Item-Responses by Program

Items	Program Responses					
	1	2	3	4	5	6
1. Subject Area	Math	Math	Reading	Math	Math	Math
2. Curriculum Role	Sup.	Sup.	Sup.	Sup.	Sup.	Sup.
3. Mode of Interaction	D&P Comp	D&P Comp	D&P Tut	D&P	D&P Comp Tut	D&P Comp
4. Intended Users	Inf'd	Spec'd	Spec'd	Spec'd	Spec'd	Spec'd
5. Target Audience	K-8	1-8	1-12	K-8	K-8	1-6
I. INTENTS						
6. Major emphasis: rationale	Dev Skills; Sup Res's	Dev Skills; Sup Res's	Dev Skills; Present Concepts	Dev Skills; Sup Res's	Dev Skills; Sup Res's	Dev Skills; Sup Res's
7. Objectives:	Inf'd	Inf'd	Spec'd	Inf'd	Inf'd	Inf'd
Major Emphasis	Recall	Recall	Abstraction; Critical thinking	Recall	Recall	Recall
8. Instructional Strategies: Obj's stated behavior'ly	N	N	A	N	N	N
Obj's terms of learner	N	N	A	N	N	N
Obj's higher order skills	N	N	A	N	N	N
Learners informed of objs	N	N	N	N	N	N
II. CONTENTS						
9. Scope: Range is adequate	Yes	Yes	No	Yes	No	Yes
Scope is adequate	Yes	Yes	Yes	Yes	Yes	Yes
10. Sequence:	Natural Units; Task Analysis	Natural Units; Task Analysis	Natural Units; Task Analysis	Natural Units; Task Analysis	Natural Units; Task Analysis	Natural Units; Task Analysis

Table 4 (continued)

Items	Program Responses					
	1	2	3	4	5	6
11. Student sequence	Set by teacher	Set by teacher	Set by program	Set by teacher or student	Set by teacher or program	Set by teacher or student
12. Student entry into and out of an activity	Varied by teacher and student	Varied by teacher and student	Fixed by program	Fixed by program	Varied by teacher	Varied by teacher and student
13. Instructional Strategies:						
Preinstructional						
Pretests are used	N	N	A	N	S	A
Advanced organizers used	N	N	N	N	N	N
Unit titles used	S	N	A	N	N	N
Instructional Text Format						
Information is formatted	S	A	N	A	A	S
Labels/headings used	S	N	N	A	N	N
Sentence Structure is easily understood	S	A	N	—	N	A
Concept Learning						
Program uses examples	NA	NA	A	NA	NA	NA
Program uses nonexamples	NA	NA	A	NA	NA	NA
Practice in varied contexts provided	NA	NA	N	NA	NA	NA
Enhancing Retention						
Vocabulary is appropriate	S	S	A	S	A	A
When used graphics are:						
embedded in content	N	N	N	N	S	A
used for enhancement	S	S	N	S	S	S
Graphics are appropriate:						
relevant for user	S	S	N	A	A	A
not distracting	S	N	N	S	A	A
support intents	N	N	N	S	A	A
Cues/prompts used	S	A	S	N	A	N
Action occure on screen	S	S	N	S	N	S
A demonstration of the exercise is given	N	N	S	N	S	N

Table 4 (continued)

Items	Program Responses					
	1	2	3	4	5	6
III. METHODOLOGY						
14. Teacher training	Never Men'd	Never Men'd	Never Men'd	Never Men'd	Never Men'd	Never Men'd
Teacher Guidance	General Sugges-tions in T.M.	General Sugges-tions in T.M.	General Sugges-tions in T.M.	General Sugges-tions in T.M.	General Sugges-tions in T.M.	General Sugges-tions in T.M.
15. T.M. provided:						
enough technical info	Yes	Yes	Yes	Yes	Yes	Yes
general strategies	Yes	Yes	No	Yes	No	Yes
specific activities	No	No	No	No	No	No
clear instructions	Yes	Yes	Yes	Yes	Yes	No
16. Instructional Strategies						
Instructions for student in program are adequate	N	N	S	N	N	N
User can control:						
time for solving prob.	N	N	N	A	N	N
rate display presented	A	A	A	A	A	A
choice of sequence	N	N	N	A	N	S
where entry must begin	N	N	N	A	N	N
exiting an activity	A	A	N	A	N	A
reviewing instructions	S	N	N	A	N	N
options in sequence	S	S	N	N	S	A
IV. MEANS OF EVALUATION						
17. A computer-management system is included	No	Yes	Yes	No	No	Yes
18. The management system includes supplementary print materials	Yes	Yes	No	No	Yes	No
19. Tests included:	None	None	Pretest Unit Mastery	None	Pretest Mastery	Pretest

Table 4 (continued)

Items	Program Responses					
	1	2	3	4	5	6
20. Instructional Strategies Feedback used after both responses	A	A	S	A	A	A
Feedback explains why response is wrong	S	N	A	N	N	N
Feedback informs what correct response is	S	A	A	A	A	A
Feedback responses are varied	N	A	S	N	S	N
Feedback uses graphics	S	A	N	N	S	A
Feedback uses print	A	A	A	A	S	A
Feedback uses audio	N	N	S	N	N	S
Feedback is appropriate:						
is non-threatening	A	S	S	A	S	A
is immediate	A	A	A	A	A	A
doesn't over-reinforce correct responses	A	N	A	A	A	A
it remediates	N	N	A	N	N	N
it doesn't reinforce wrong responses	A	A	A	A	A	A
is relevant for user	S	S	A	A	A	A
The management system uses diagnostic mangmt.	N	A	A	N	S	A
Records are stored on magnetic device	N	A	A	N	N	A
Records are stored on printed sheets	A	A	N	A	A	N
V. CONGRUENCE						
21. Congruence displayed	Yes	Yes	No	No	Yes	Yes
VI. TECHNICAL CONSIDERATIONS						
22. Frame display appropriate	S	A	N	S	A	S
23. Program is technically easy to use	A	N	A	S	A	N
24. Random generation used	A	A	N	A	A	A

Table 4 (continued)

Items	Program Responses					
	1	2	3	4	5	6
25. Packaging is well-designed	N	A	A	A	N	N
26. Documentation of development provided	No	No	Yes	No	No	No

*Key: Sup. = Supplementary
D&P = Drill and Practice
Comp = Computation
Tut = Tutorial
Inf'd = Inferred
Spec'd = Specified
Dev Skills = Develop skills
Sup Res's = Supplement Resources
N = Never
S = Sometimes
A = Always
NA = Not Applicable
Never Men'd = Never Mentioned
T.M. = Teacher's Manual
Obj's = Objectives

It is possible to derive some conclusions based upon the data analyzed in Table 4. The following results may be noted:

o Most programs on the market are a drill and practice application for supplementary use in the classroom;

o 95% of the large, computer-managed packages are arithmetic programs;

o Most of the programs specify who the intended users are but many of them recommend too wide of an audience (i.e., elementary, junior high, high school and adults);

o All of the programs are designed to be used in elementary to junior high school (K - 8). No large package is available for high school;

o The major emphasis of the rationale in the programs is to develop skills in a particular area and to supplement other resources;

o The major emphasis of the objectives in the programs is recall of previously learned facts;

o Most of the programs' objectives do not include higher order skills such as comprehension, application, analysis, synthesis, and evaluation;

o Scope of the content material is appropriate for learning levels of intended users in all programs except for one. The range (or depth of coverage) of the content is adequate to achieve the program's intents in all of the programs except two;

o Few preinstructional strategies are used to help orient the student to the content. Most of the programs do not even use a title at the beginning of each unit in the program;

o About half of the programs format instructional text adequately. Sentence structure is a problem in about half of the the programs;

o Few programs teach concepts and the only one that attempts to, does not use any systematic method based upon research for teaching of the concepts;

o Rarely are graphics embedded in the instructional content. When used, graphics tend to enhance either the instructional content or feedback;

o All the programs contain a Teacher's Manual. The Teacher's Manuals provide enough technical information to familiarize the teachers with technical use of the program and with very general classroom strategies. None of them provide lesson plans or specific activities to integrate the programs into the curriculum;

o Most of the programs grant the user control in only two areas: 1) over the rate the display material is presented so the user can read the information at his/her own pace, and 2) over exiting an activity at any time;

o All programs use feedback to reinforce both correct and incorrect responses even though research recommends that feedback be used after wrong responses only and that an intermittent schedule sustains learning at the highest rate;

o Most of the feedback responses do not remediate the wrong answer. Only one program informs the user why the response is wrong although they all inform the user what the correct response is.

o Half of the programs use diagnostic management (i.e., the program branches by varying the level of difficulty as a result of performance);

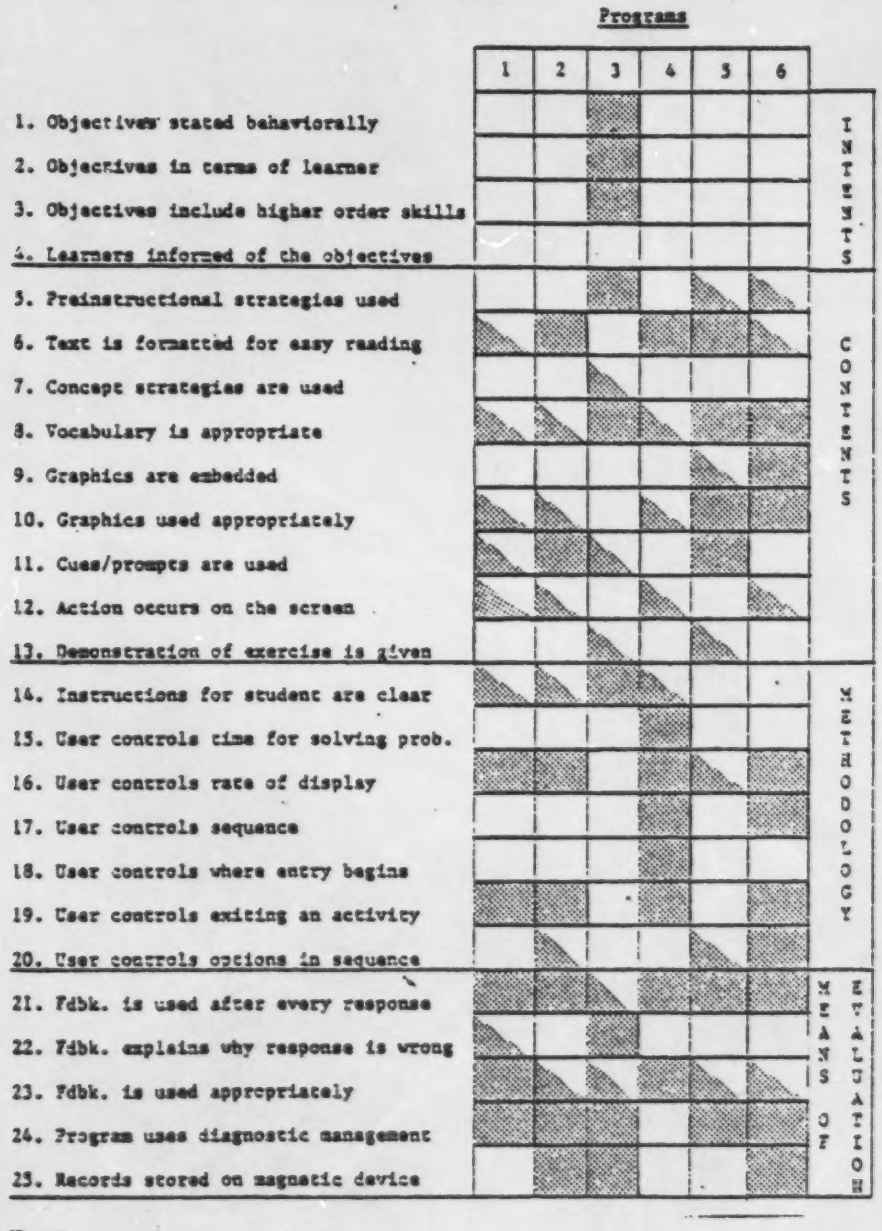
o Half of the programs have cumulative records that are stored on an external magnetic device for future retrieval. Two-thirds of them also contain printed sheets in the Teacher's Guide to manually store the records.

Instructional Strategies

Table 5 represents the use of instructional strategies in the microcomputer courseware programs. From this table it is possible to draw some conclusions regarding those strategies that are being employed by publishers to facilitate learning.

Table 5

Use of Instructional Strategies



Looking at Table 5, few instructional strategies are being utilized with regards to the Intents. Rarely are objectives labeled or specified as such, stated behaviorally in terms of the learner, or stress any higher-order skills such as comprehension, application, analysis, synthesis, and evaluation. The greatest impact of the programs tends to be on the lowest level of Bloom's Taxonomy--recall. None of the programs inform the learner of what is to be taught by presenting the specific objectives of the lesson. Despite the fact that research recommends using objectives as an orienting or reinforcement stimulii which enhances relevant learning (Duchastel and Merrill, 1973; Hartley and Davies, 1976; Wittrock, Note 4), none of the current programs produced by the publishing companies are employing this technique. The use of specific behavioral objectives is not widely used and although skill strands will be elaborated for the teacher in the Teacher's Manual, the publishers are not specifying actual objectives.

In looking at the Contents, rarely are any preinstructional strategies employed, except for pretests. Two programs always use pretests and one program sometimes uses them. With the technology being so new, students should be prepared for and introduced to this new and unusual learning experience so that the learning process is facilitated, retention is enhanced and the anxiety level is minimized. Few programs contain any kind of introductory statement or preinstructional strategy to preface the

teaching.

Most programs are trying to format the information for easy reading but more effort and research in this area is needed to determine what appropriate formatting should include. Especially when a program emphasizes reading skills, it becomes mandatory that the information be formatted. The one program that emphasized higher-order objectives was a reading program; it has such a poorly formatted screen that it became impossible to sit and read the text for a prolonged period of time. Rarely are labels or headings used to identify different kinds of information. And in the Math programs there was so little text to format that sentences were virtually nonexistent.

Unfortunately, most programs are not trying to teach concepts. The one program that does, fails to provide practice of the concepts in varied contexts and the analysts could never determine if these concepts were situation-specific or would generalize beyond the lesson. The need to teach concepts in a systematic fashion is mandatory.

Few of the programs utilize strategies to enhance retention. Most programs use graphics as part of the feedback. Only two programs attempt to use graphics that are embedded in the instructional content and even in these cases, the graphics are not as appealing and compelling as the could be. Action rarely occurs on the the screen to motivate students' interest and provide some unique

representation of the information. Most programs are basically boring. Only two programs give a demonstration of the exercise, another important strategy which would facilitate learning and reduce anxiety over the new technology.

In looking at the Methodology construct, publishers are not utilizing an important and necessary strategy, providing clear and concise instructions for the student. They rarely provide any guidance in terms of directing the student through the program. Often a student would be presented with a complex math problem with the cursor sitting over the hundreds column and there would be no indication of what to do next. In some programs instructions are virtually nonexistent.

Little user control is being granted to the learner so that the learner can start becoming more responsible for his/her own learning sequence. As noted on Table 5, only one program allows the student to determine where entry into the program can begin and that program is not a major curricular package. That same program allows the student to set his/her own rate that the problems are presented so that s/he can determine the amount of time allowed for solving the problem. The student can then answer ten problems in five seconds if so desired. A few programs are offering some control over options available in the sequence such as "HELP", "ESCAPE", and "ERASE" keys. Only two programs give the students the ability to control their own sequence in

the program.

In looking at the Means of Evaluation construct the one strategy most programs fail to utilize is explaining why the response is wrong. This important piece of information might be difficult to include in the feedback response as it demands an extremely interactive, personalized response from the computer. Most programs are just telling the user what the correct answer is and often this is not given immediately but after the lesson is over or a corrective session has occurred. At that time, the wrong response has been forgotten and it is no longer possible to compare the wrong answer against the right answer. The corrective function of feedback has then been defeated.

The state of the art of microcomputer courseware is such that this is really the first year that publishers have attempted to produce software. It seems natural to expect them to approach the market with trepidation and to make some first attempts. It is mandatory that the consumers of such software become aware of those strategies and attributes with will enhance instruction so that the first attempts can be revised, especially in a medium such as this one which can be easily "debugged" and changed. Consumers can have a powerful voice, but only if they are aware of what qualities to look for.

Significance

From this study a courseware evaluation form for the microcomputer has been developed and utilized by eight analysts in an evaluation project. The form is unique in that it was designed and developed to evaluate the capabilities of the microcomputer and therefore looks specifically at how that technology can best be used to facilitate instruction. In addition, a list of criteria has emerged which could become a potential "checklist" for those who are developing, selecting or evaluating instructional software for the microcomputer. This list is basically a starting point for further research and could be validated through empirical investigation to determine which criterion-items significantly effect learning outcomes.

A procedure for evaluating instructional software programs has also been piloted during this study. This procedure can yield guidelines on the recommended approach to follow in conducting evaluation studies of instructional materials.

Lastly, this study has attempted to assess the current state-of-the-art of large commercial software packages being marketed for school use. It is hoped that such a study will have a direct effect upon the market by 1) making consumers and developers more aware of specific instructional strategies that should be employed when utilizing the unique capabilities of the microcomputer and 2) thereby improving the overall quality of software programs being produced.

The following recommendations need to be addressed by publishers and consumers of instructional software for the microcomputer in the near future.

1.) There is a great demand for programs which teach critical thinking skills, problem-solving techniques and higher-order skills such as application and synthesis of concepts. As of now there are very few programs which even attempt to do this.

2.) There is a great need to have programs designed for students in middle school and especially high school.

3.) More ways of interacting with the microcomputer other than just drill and practice need to be explored by publishers. Tutorials and simulations should be used more often.

4.) The programs need to expand beyond just arithmetic skills. The microcomputer is particularly well-suited for teaching writing skills via a word-processing or text-editing program. Language arts, social science, foreign languages, science and business applications all need to be developed.

5.) An easy, effective management system needs to be explored to help the teacher individualize instruction. Two programs right now have a fairly sophisticated management system, yet both are somewhat cumbersome and difficult to access.

6.) The whole concept of interactivity will have to be explored so that the microcomputer will respond to each individual student's personal needs. Options from menus and special keys such as "HELP" and "ESCAPE" should be used so a student can explore a subject matter in his/her own cognitive style. Moreover, as the computer becones more capable of interacting effectively with the user, the computer must be viewed as "friendly" and interminably patient, a factor of how the software program is designed. Too often, programs are written in a dogmatic and threatening style, perhaps perpetuating the designers point of view. This must be guarded against so that learning is encouraged and not forced.

7.) More research on feedback should be conducted. It cannot be assumed that reinforcing students after every response is the only way to give feedback. For very young children or slower learners an abundance of positive feedback might be necessary, and an option should be available to use it intermittently if desired.

8.) More sophisticated use of graphics which are embedded in the instructional content and used appropriately is needed.

9.) Publishers will have to address incorporating motivational devices into the courseware programs. There is a whole science of motivating students via gaming, graphics, appropriate use of feedback, and instructional design. Such techniques must be used so that the software programs become

compelling and exciting unto themselves and stimulate students to learn.

10.) The whole issue of integrating the microcomputer into the curriculum will have to be addressed by the publishers. Many more specific activities and lesson plans for the teacher and student should be made available. As the concept of courseware expands supplementary materials should become available which will help integrate the microcomputer into the classroom by specifying how the courseware program and various textbooks can be coordinated in one lesson. Units in courseware programs will be directly correlated to chapters in the text and a teacher will be able to create a lesson from this media-match. One program on the market has developed such a cross-reference book which is an excellent feature.

11.) Packaging of the programs should be designed for media specialists who will ultimately be responsible for the cataloging, storage and dissemination of the programs throughout the school. This means that component parts should be separately packaged and labeled, numerous copies of the Teacher's Guide should be included, and the total program should be in a container that is carefully designed not to loose the disks, tapes or modules.

This study has looked at the field of instructional design and how it applies to courseware for the microcomputer. It has responded to an evident need of

supplying consumer information to school districts in the hope that such information can make the consumer more aware of what good software is. As the "newest" field in the industry, software development is only starting to be recognized as an integral part of the market, a market whose ultimate fate will probably depend upon the quality of the software packages being produced. By becoming aware of the capabilities and limitations of the microcomputer, schools will become better consumers and users of courseware for the microcomputer.

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APPENDIXES

APPENDIX A:

GLOSSARY

Glossary

Computer-assisted instruction (CAI): An interaction between a student controlled display, and a response-entry device for the purpose of achieving educational outcomes (Bunderson, 1976).

Concept: A class or category in which all members share a particular combination of critical properties not shared by any other class (Markle and Tiemann, 1970).

Contents: The scope and sequence of the subject matter to be included, and the learning activities to be presented (EPIE Materials Report, 1977).

Courseware: The software and all the supplementary print materials that constitute a complete course of study. Thus, a courseware package might include a magnetic tape or floppy disk and also a videotape, a set of microfiche cards, and a set of printed materials.

Discs: Medium for storing digital information apart from the computer's main memory. It has a magnetic coating for storage and retrieval of information and are more efficient than tapes (Frederick, 1980).

Drill and practice: Designed to supplement regular instruction received elsewhere by providing a means by which concepts presented and developed in the classroom can be practiced and refined at the computer (O'Neil and Richardson, 1977a).

EPIE: Educational Products Information Exchange Institute was founded in 1969 as a non-profit educational consumers organization. As well as providing information on material content and selection procedures, EPIE is also engaged in research on materials-use and the effectiveness of various teaching strategies with given materials (verbal communication, K. Komoski, Note 1).

Feedback: The message or compound statement which follows the response made by the learner (Hartley and Lovell, 1978).

Game: A situation where students have to know certain facts, perform certain skills, or demonstrate mastery of certain concepts; winning depends upon mastery of these cognitive skills (Seidner, 1976).

Hardware: Equipment, including computers, disk drives, cassette players, cables and monitors.

Intents: The rationale, the goals, and the objectives of

the intended instruction (EPIE Materials Report, 1977).

Learner control: Adaptive instructional decisions made by the student as compared with system control where adaptive instructional decisions are made for the student; levels of conscious processing in an instructional program over which a learner can exercise control (Merrill, Kowallis and Wilson, Note 3).

Means of Evaluation: The approaches to assessment and evaluation of learning outcomes which are provided, or, at least, suggested in instructional materials (EPIE Materials Report, 1977).

Methodology: The teaching/learning transactions or methods which are to be employed in an instructional material (EPIE Materials Report, 1977).

Microcomputer: A computer that costs roughly $200 to $6,000 with the major computational capabilities concentrated in one electronic component called a "chip". Generally, it can not only do computations but can also communicate with terminals and store relatively large quantities of data. The functional components are the same as a larger computer system which includes: input, memory, output, and a central processing unit (CPU). Memory usually ranges from 4K (enough space to store about 4,000 characters) to 64K (about 64,000 characters). The commonly available language is BASIC (Frederick, 1980; Milner, 1980).

Scope: The range of subject matter or skills to be introduced, or covered, in pursuit of goals and objectives (EPIE Materials Report, 1977).

Simulation: The dynamic execution or manipulation of a model of some object system so that the student can interact with and become part of that simulated reality (Seidner, 1976).

Software: Generally refers to programs and data, as differentiated from "hardware", the physical parts of a computer (Milner, 1980).

Tape: Medium for storing digital information apart from the computer's main memory. It has a magnetic coating for storage and retrieval of information (Frederick, 1980).

Tutorial: Intended to stand alone as an instructional entity; teaches rules and concepts embodied in the subject matter as well as evaluating the student's comprehension of these concepts (O'Neil and Richardson, 1977a).

APPENDIX B:

EVALUATION INSTRUMENT

Analyst Name_____ Date_____19____

I. IDENTIFICATION AND BACKGROUND

A. Bibliographic Information

1. Title:_____
2. Authors:_____
3. Manufacturer or Publisher:_____
4. Address:_____
5. Copyright Date(s) (if no date, specify):_____
6. Cost:_____
7. Available for what microcomputer(s) (model and memory):_____

_____

B. Components

A Teacher's Guide for the whole program ____ is included
____ is not included

Grade Level	Title	Cassette	Disk	Module	Separate Tchr's Guide
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___
_____	_____	___	___	___	___

*Indicates not available for analysis

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C Support Related Materials

Give title, type of medium (print, video, audio cassette, film, etc.), producer/source, and role they play in the program.

Title	Medium	Producer	Role in program (e.g., required or supplementary

D. Program Application

1. Subject Area(s): _____

2. Curriculum Role:
   - ____ Supplementary/Adjunct
   - ____ Basic Course/Mainline
   - ____ Management Only
   - ____ Other _____

3. Mode of interaction (check as many as apply):
   - ____ Drill and practice
   - ____ Tutorial
   - ____ Gaming
   - ____ Simulation
   - ____ Problem Solving
   - ____ Exploration

E. Program Users

1. Intended Users: _____
   - ____ Specified in materials
   - ____ Specified in Teacher's Guide
   - ____ Inferred

2. Learner Entry Competencies: _____
   - ____ No special competencies required
   - ____ Competencies required but not specified
   - ____ Special competencies specified in: _____
     _____

3. Target Audience that the Analyst feels program should be utilized for:
   - ____ same as specified in materials
   - ____ different than specified in materials:
     _____
     _____

II. INTENTS

A. Developer's Rationale

1. ____ Specified by developer ____ Inferred by analyst
2. Source:_____

Rationale:_____ (Check as many as apply):

_____
_____ ____ Develop skills in particular area
_____ ____ Present concepts and principles
_____ ____ Supplement other resources
_____ ____ Apply specific instructional approach
_____ ____ Serve special group of learners
_____ ____ Introduce subject matter content in
_____ a unique or specific way.
_____ ____ Other:_____

B. Learner Objectives

1. ___ Specified by developer ____ Inferred by analyst

Source:_____

2. Example of Objectives:_____ Major emphasis of objectives are:
_____ (Check as many as apply):

_____
_____ ____ Recall of previously learned facts
_____ ____ Application of specific skill(s)
_____ ____ Abstraction beyond concrete level
_____ ____ Transfer of learning (i.e., to
_____ real life situations)
_____ ____ Critical thinking skills
_____ ____ Create specific feelings and
_____ attitudes
_____ ____ Develop study skills
_____ ____ Other:_____

C. Instructional Strategies

	Always Present	Sometimes Present	Never Present
1. Objectives are stated behaviorally. Comments:_____	____	____	____
2. Objectives are stated in terms of the learner. Comments:_____	____	____	____
3. Objectives include higher order skills such as comprehension, application, analysis, synthesis, and evaluation. Comments:_____	____	____	____
4. Learners are informed of the objectives. Comments:_____	____	____	____

III. CONTENTS

A. Content Scope

1. Topics Covered (list main topic(s), theme(s), units covered):

_____

_____

	Yes	No
2. Range of content material is adequate to achieve program's intents.	_____	_____
3. Scope is appropriate for learning levels of intended users.	_____	_____

B. Content Sequence

1. ____ Specified by developer ____ Inferred by analyst

2. Source: ____ Documentation ____ Teacher's Manual

____ Catalogue ____ Other:_____

If specified, briefly describe sequence of content:_____

_____

_____

3. Total program sequence: (Check as many as apply)

Comments:_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

____ Chronological

____ Unit (natural unit in subject matter)

____ Problem-centered

____ Task Analysis (breaking task into parts and teaching progressively harder steps)

____ Dictated by learning approach (i.e., simulation, game)

____ Other_____

4. Student sequence through the total program:

Comments:_____

_____

_____

	Yes	No
Is set by program	___	___
Is set by teacher	___	___
Is left to user	___	___

5. Students' entry into and out of an activity:

Comments:_____

_____

_____

_____

_____

_____

_____

	Yes	No
Is fixed by program in set sequence and user must continue through whole sequence	___	___
Can be varied by user	___	___
Can be varied by teacher	___	___

C. Preinstructional Strategies

	Always Present	Sometimes Present	Never Present
1. Pretests are used.			
Comments:_____	___	___	___
_____			
2. Advanced organizers such as pre-questions, overviews, and summaries are used.			
Comments:_____	___	___	___
_____			
3. Clear and concise title is presented at the beginning of each unit in the program.			
Comments:_____	___	___	___
_____			

D. Instructional Strategies

Instructional Text Format:			
1. Information is formatted for easy reading.			
Comments:_____	___	___	___
_____			
2. Labels or headings identify different kinds of information.			
Comments:_____	___	___	___
_____			
3. Sentence structure is easily understood for user population (i.e., sentences aren't too long or too short).			
Comments:_____	___	___	___
_____			
Concept Learning:			
4. The program uses a number of examples to teach each concept.			
Comments:_____	___	___	___
_____			

	Always Present	Sometimes Present	Never Present
Concept Learning:			
5. The program uses a number of nonexamples to teach each concept.			
Comments:_____	___	___	___
_____			
6. Practice in varied contexts is provided.			
Comments:_____	___	___	___
_____			
Enhancing Retention:			
7. Vocabulary is appropriate for the user.			
Comments:_____	___	___	___
_____			
8. When used, graphics are:			
a. embedded in the instuctional content (i.e., are an essential part of instruction)	___	___	___
b. used for enhancement only (i.e., are not part of the content but used to enhance presentation or feedback)	___	___	___
Comments:_____			
_____			
9. Graphics are used appropriately:			
a. are relevant for user's age and level	___	___	___
b. are not distracting	___	___	___
c. support program's intents	___	___	___
Comments:_____			
_____			
10. Cues and/or prompts are used after wrong response.			
Comments:_____	___	___	___
_____			
11. Action occurs on the screen (i.e., there is graphic movement other than just words; specify if used in content, feedback only, or both).			
Comments:_____	___	___	___
_____			
12. A demonstration of the exercise is given.			
Comments:_____	___	___	___
_____			

IV. METHODOLOGY

A. Presentation

1. Methods for using the materials are:

   _____ Specified by developer _____ Left to user ____ Left to Teacher

2. Source: _____ Teacher's Guide or instructional suggestions

   _____ Directions in program _____ Other:_____

B. Instructional Approach

1. Briefly describe the instructional approach used in organizing the activities of this program (i.e., what does a teacher and/or student have to do to progress through a unit?).

C. Teacher Use

1. Teacher Training:

   Comments:

   _____ Is specified

   _____ Is not mentioned

2. Teacher Use/Guidance:

   Comments:

   _____ Inservice Training

   _____ Lesson plans in Teacher Guide

   _____ General suggestions in Teacher's Guide

   _____ No guidance provided

D. Teacher's Manual

1. _____ Is provided _____ Is not provided

	Yes	No
2. Content provides:		
Enough information to familiarize teacher with technical use of program	___	___
Classroom strategies for use of program	___	___
Specific instructional activities to integrate program into curriculum	___	___
3. Instructions:		
Are well organized	___	___
Are clearly stated	___	___
Provide step-by-step approach	___	___

Comments: _____

_____

_____

_____

_____

_____

_____

E. Instructional Strategies

	Always Present	Sometimes Present	Never Present
1. Instructions in the program for the student are easily understood.	___	___	___
2. Instructions in the program for the student are concise.	___	___	___
3. Please consider the extent to which the user can control the rate and sequence of presentation over:			
a. amount of time allowed for solving each problem	___	___	___
b. rate that display material is presented so user can read information at own pace (i.e., can user speed up or slow down the rate that material is presented?)	___	___	___
c. choice of sequence so user is not confined to linear path	___	___	___
d. where entry into program must begin	___	___	___
e. exiting an activity at any time	___	___	___
f. reviewing instructions	___	___	___
g. options available in sequence such as "HELP," "HINT," "ESCAPE" keys	___	___	___

Comments: _____

_____

V. MEANS OF EVALUATION

A. Management System/Tests

1. Computer-Managed Instruction (i.e., management of the student's performance is done by the computer)
   _____ is used by the program
   _____ is not used by the program

2. The following functions are implemented by the computer-management system:
   _____ Data collection and storage from the learning situation
   _____ Diagnosis (i.e., computer determines the status of student's observed performance)
   _____ Prescription based upon student data (i.e., computer moves a student forward to the next unit or assigns a student activities to eliminate a deficiency)
   _____ Reporting

3. Tests
   _____ are included in the program
   _____ are supplementary print materials
   _____ are not included

4. Tests are specified to be used as: (Check as many as apply)
   _____ Pretest(s)
   _____ Unit test(s)
   _____ Diagnostic test(s)
   _____ Mastery test(s)
   _____ Other:_____

   Comments:_____
   _____
   _____
   _____

B. Instructional Strategies

	Always Present	Sometimes Present	Never Present
1. a) Feedback is used after correct responses only.	____	____	____
b) Feedback is used after incorrect responses only.	____	____	____
c) Feedback is used after both kinds of responses.	____	____	____
2. Feedback explains why the response is wrong.	____	____	____

Comments:_____
_____
_____

Comments:_____
_____

	Always Present	Sometimes Present	Never Present
3. Feedback informs what the correct response is after _____ wrong attempts.	___	___	___
Comments:_____			
4. Feedback responses are varied:			
a) from activity to activity.	___	___	___
b) within each activity.	___	___	___
Comments:_____			
5. Feedback uses: a) graphics	___	___	___
b) printed words	___	___	___
c) audio output	___	___	___
Comments:_____			
6. Feedback is used appropriately:			
a) it is non-threatening	___	___	___
b) it is immediate	___	___	___
c) it appropriately reinforces correct responses	___	___	___
d) it appropriately reinforces wrong responses	___	___	___
e) it remediates	___	___	___
f) it is relevant for user's age and level	___	___	___
Comments:_____			
7. If records exist, they are informative.	___	___	___
Comments:_____			
8. Records are easily accessible by teacher.	___	___	___
Comments:_____			
9. Cumulative records for each student:			
a) are stored on a magnetic device for future retrieval.	___	___	___
b) are to be manually stored on printed sheets provided in the Guide.	___	___	___
Comments:_____			

VI. INSTRUCTIONAL DESIGN CONGRUENCE

A. Instructional Design Provisions

	YES	NO
1. Intents match content	___	___
2. Intents match methodology	___	___
3. Intents match means of evaluation	___	___
4. Content matches methodology	___	___
5. Content matches means of evaluation	___	___
6. Methodology matches means of evaluation	___	___

Comments: _____

VII. USE CONSIDERATIONS

A. Technical Considerations

		Always Present	Sometimes Present	Never Present
1. Graphics:				
Comments: _____	Have clear resolution	___	___	___
	Are in color	___	___	___
	Are presented clearly for maximum understanding	___	___	___
2. Audio Output:				
Comments: _____	Is clear	___	___	___
	Is realistic	___	___	___
	Contributes to program's value	___	___	___
3. Frame Display:				
Comments: _____	Is clear of clutter	___	___	___
	Is formatted for easy reading	___	___	___
	Is cleared before each new display	___	___	___
4. Program Content:				
Comments: _____	Is designed to be altered by teacher adding to it	___	___	___
	Is designed to be altered by student adding to it	___	___	___
	Is technically easy to utilize in computer	___	___	___

		Always Present	Sometimes Present	Never Present
5. Random Generation:				
Comments: _____	Is used in practice activities	___	___	___
	Is used in feedback	___	___	___
6. Tapes/Disks are accurate in:				
Comments: _____	Spelling	___	___	___
	Grammar	___	___	___
	Word Usage	___	___	___
7. Packaging of the program:				
Comments: _____	Is well-designed for component parts	___	___	___
	Contains as Instructor's Guide	___	___	___
8. The writing style:				
Comments: _____	Is appropriate for user population (i.e., not too mechanical, cute, patronizing, etc.)	___	___	___
9. Content:				
Comments: _____	Is accurate	___	___	___
	Is free of sexual bias	___	___	___
	Is free of racial bias	___	___	___
	Is free of ethnic bias	___	___	___
10. Design of program:				
Comments: _____	Is organized in a consistent fashion across different units (i.e., Is the structure of an addition unit parallel to the structure of other units in the program?)	___	___	___
11. Technical design of program:				
Comments: _____	Allows for quick response time on the computer (i.e., the computer responds quickly once the keys are depressed)	___	___	___
	Allows for quick loading of the program (i.e., a lot of time isn't spent waiting for parts of the program to be loaded in memory	___	___	___

B. Development

1. _____ Program has been field-tested.
2. _____ Documentation of Learner-Verification and Revision is provided.
3. _____ No documentation of development and/or research has been provided.

Comments:_____

SUMMARY STATEMENT

Please comment on the following in your summary statement: the beneficial points of this program, specific improvements and recommendations the developer could attend to, if the program utilized the unique capabilities of the computer, and your intuitive feelings regarding the overall quality of the program.

APPENDIX C:

EXAMPLE OF DATA LIST FOR PROGRAM 2

Coded Responses

Item #	1	2	3	4	5	6	7	8
I.D1	7							
2	7							
(3)*	7	1	1	2			4	1
(II.A2)	7		4	1			3	
B2	7	5	1					
C1	1		6					
2	1	1	5					
3		1	6					
4			7					
III.B3		7						
4	1	7						
(5)		3	7					
C1			7					
2			7					
3	6	1						
D1	6		1					
2	1	1	5					
3	6		1					
4	1	5	1					
5			7					
6	2		5					
7			7					
8	4	1						
9	2	5						
10		4	2					
11	5	1	1					
(12)	3	4						
IV.B1		7						
2		5	2					
(C2)	6	4						
3	7	7	7					
(D1)	3	3	1					
2	5	1	1					
3	1		5					
(4)	1	2	4					

* Indicates those items which show variance

Coded Responses

Item #	1	2	3	4	5	6	7	8
V.A1	6	1						
2	1		6					
B3	7							
4		2	5					
5	7							
6a	5							
b	6	1						
7a	6	1						
b	5	1	1					
c			7					
8	1	5	1					
9a	6							
b	5	1	1					
(10)	2	3	2					
(11)	3	1	3					
12	5		2					
13a	7							
b	5	1	1					
VI.A1	7							
2	7							
3	7							
4	7							
5	7							
6	7							
VII.A1a	7							
b	7							
c	6							
(d)	3	3	1					
2a			2					
b			2					
c			2					
3a	6	1						
b	5	2						
c	7							
4a	2		5					

Item #	Coded Responses 1	2	3	4	5	6	7	8
4b	1		6					
c	5		2					
5a	5		2					
(b)	3	1	3					
6a	7							
b	7							
c	6	1						
7a	7							
b	7							
(8A)	3	3	1					
9a	6	1						
b	7							
c	7							
d	7							
10a	7							
13a	1	6						
b		7						
c	1	6						

"END OF DOCUMENT"